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San Francisco, California
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ENTOMOLOGY IN WESTERN PINE SILVICULTURE*

BY F. P. KEEN

U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine

From the layman's view all insects are pests and the only function of entomologists is to find ways of exterminating or controlling them. The emphasis has been on discovering new insecticides, new sprays, new fumigants, new and more powerful DDT's to make this an insect-free world. But entomologists realize that insects have an important function in Nature, that there are many beneficial and useful forms, and that to destroy all insects would be a great catastrophe. Even destructive forms frequently have proved to be a blessing in disguise, as was so well recognized in the South when a monument was erected to the cotton boll weevil for having brought diversified agriculture and hence a more sound agricultural economy.

In forest entomology we have gone through the stages of collecting, describing, naming, and cataloging myriads of species found under forest conditions. Thousands of species still remain unnamed, for forest tree crops are unique in having a tremendous insect fauna constantly associated with them. We cannot conceive of growing forests insect free. Forests, in fact, are a fertile hunting ground for the collector, and taxonomists still have much work to do and re-do, for many forest-insect groups still need classification and extensive revision after comprehensive studies have been made of their biology, internal and external morphology, distribution, and intergradation of species.

We have also gone through the stage of developing control methods for the more destructive forms (6), including direct control for bark beetles by felling, peeling, and burning (4); penetrating oil sprays for bark and wood borers (22), and airplane dusting and spraying for forest defoliators (5). All these

*Presidential address read before the Pacific Coast Entomological Society, January 12, 1946.

direct control methods have their usefulness and limitations and, while great progress has been made in this field during the past forty years, many newer and better methods may still be evolved.

But to me the more interesting and constructive contribution of entomologists to forestry is in the field of forest management (3, 17)—the discovery of the role insects are playing in forest ecology and how native forest insects are giving the clue to good silviculture in many forest types. Through the ages insects of the forest have been pruning, thinning, weeding, and felling—crude silviculture perhaps, but yet managing to bring forests through to the condition in which they were found when the early pioneers first viewed in awe the virgin forests covering our mountain slopes. While the sluggard turns to the ant for his model of industry, the forester turns to the bark beetle to learn how to manage a forest.

A good example of this development is furnished by recent studies of the western pine beetle (*Dendroctonus brevicomis* Lec.) and its role in the ponderosa pine forests of the Pacific Coast States (2, 14). This bark beetle is indigenous to ponderosa pine forests and undoubtedly has always been associated with these trees. During the last 20 years it has killed an estimated 27 billion board feet of timber in California, Oregon, and Washington, according to Bureau of Entomology and Plant Quarantine survey estimates, or enough timber to keep all the pine mills in this region operating for 14 years at normal capacity. In some places from 60 to 90 percent of the mature pine stand has been destroyed.

Why this stupendous damage? And if this is the pattern of this beetle's behavior, why haven't these forests been wiped out long ago? For the past 25 years or more forest entomologists have been seeking answers to these questions. Today we believe the solution is in sight—not only a solution to means of controlling this bark beetle, but the more important solution to the problem of how best to manage ponderosa pine forests for their maximum yield of timber on a sustained basis.

While considerable study was given to the biology, life history, and habits of the western pine beetle prior to 1920 (1), research on the problem was greatly intensified as a result of a serious outbreak which began about 1918 in the Klamath Region of southern Oregon and northern California. Forest owners became alarmed at the heavy timber losses and obtained an appropria-

tion of $150,000 from Congress to inaugurate control on federal lands, while private owners agreed to make comparable expenditures on private lands. After preliminary surveys covering 1,267,000 acres of infested ponderosa pine forests, in the spring of 1922 was launched the largest western pine beetle control project ever undertaken (7, 8). As often happens, large-scale control stimulated greater research, particularly on the reasons for this outbreak, so that, in addition to suppression of the current bark beetle epidemic, the underlying causes might also be remedied, if possible.

Accordingly in 1922 a comprehensive study was begun of the beetle population and all contributing factors—biological, climatological, ecological and silvicultural. On the biological side the effect of predators on beetle population was studied, particularly the role of the clerid *Thanasimus lecontei* (Wolc.) (21). Parasites were found to be of negligible importance. The effect of high and low lethal temperatures was studied (15), and in 1924, 1932, 1933, and 1935 opportunities were offered for determining how effective winter temperatures below zero (Fahrenheit) were in killing beetle populations (12). A check of weather records showed that annual precipitation had been deficient since 1917 and that although the trees being killed appeared normal and healthy, they were probably suffering from drought. In 1924, therefore, a study was initiated to determine the effect of precipitation on tree growth and the relation of growth decline to western pine beetle epidemics. And here is where an entomologist strayed into the tree growth-ring field, which unexpectedly yielded results both interesting and valuable to the solution of a problem in applied ecology (10).

The first striking thing noted from increment borings was that everywhere through the pine forests of southeastern Oregon and northeastern California the 1924 ring was exceedingly small as related to the 1923 ring. Then it was noted that from 1900 to 1916 radial tree growth had been very favorable but that in 1917 a sudden drop in growth had occurred which corresponded to the beginning of the precipitation deficiency. The following years showed a sequence of small and larger rings which was similar in all trees. Obviously tree rings were recording the total effect of all climatic factors which influenced tree growth over wide areas. The changes in ring widths were then watched with interest and correlated with fluctuations in precipitation and beetle

population. From the small ring of 1924 growth improved slightly up to a fairly large ring in 1928. The beetles went through another epidemic cycle from 1923 to 1929. Then came another series of drought years, even worse than the critical year of 1924. Ring widths shrank to microscopic size, and beetle populations zoomed to their highest peak in 1932, when 1,440 million board feet of ponderosa pine were killed in the virgin forests of eastern Oregon.

Losses were so severe that the forest began to retreat from the desert edges. It looked as though the climate might have changed and that there might be no hope of ever growing forests again at the lower elevations. If this was true, beetle control was hopeless and the best the owners could do was to salvage what they could of their remaining timber stands and let these areas revert to desert.

Since tree rings were such obviously good indicators of wet and dry years, it seemed worth while to see what they might have to say about longtime trends. Was the climate getting drier? Was tree growth continuously declining? Would bark beetles continue to wipe out fringe stands? Was there no hope for pine forestry? These were some of the questions for which answers were sought through tree-ring analysis.

The investigation of tree rings proved to be more complicated than at first appeared. Rings had to be measured from hundreds of trees, from many localities. Allowances had to be made for such factors as the normal decline in radial growth with increasing age, the effect of variable tree thrift—dominant trees grow much faster than intermediate or suppressed trees—the effect of periodic fires, insect defoliators, and sudden release due to windthrow of competing neighbors. Gradually the climatic pattern of tree growth for the past 600 years unfolded, not in terms of annual precipitation but of the combined effect of all climatic factors. It was found that this region had gone through many similar poor growth periods, but not of such great length and intensity. The most nearly comparable previous drought had occurred between 1839 and 1854, when the emigrants coming over the Old Oregon Trail found Goose Lake, south of what is now Lakeview, Oregon, completely dry and were able to drive their wagons across its bed. Not until 1925 was Goose Lake dry again, and then the old wagon tracks reappeared. But most important, the tree ring record showed that, while good and poor

growth periods had waxed and waned, there had been no perceptible change in average growth rate during the entire 600 years, and from analogy we could assume that wetter years would come and that forests would again grow at the lower margin of the pine belt. This prediction has already been fulfilled, for since 1941 we have again entered a period of above-normal precipitation and tree growth, and at present the western pine beetle population has shrunk to its lowest since survey records were started in 1913.

This realization of the importance of drought and poor tree growth to the long-cycle of epidemiology of the western pine beetle also suggested that individual trees of poor growth were probably more susceptible to attack than were those of vigorous growth. Accordingly, studies were begun on the relation of growth rate to selection by the western pine beetle (19), on causes of attraction (20), and on the types of trees showing the greatest susceptibility (9). From this work was developed a tree classification (11), based on the two primary factors of tree age and vigor, which has become widely adopted by foresters as a silvicultural tool for timber-cutting and management purposes. A further development of rating individual tree health has been found most useful in making sanitation-salvage cuttings of ponderosa pine stands as a beetle-control measure (23). In fact, through sanitation-salvage cuttings, which consist of taking out trees of highest beetle risk, we have succeeded in controlling western pine beetle infestations much more effectively than by any previously used direct method of destroying beetle populations (13). Removing susceptible host trees has been more effective in controlling outbreaks than removing the beetles (18), and is also much less expensive.

A further development along this line of controlling beetles through proper management of the host tree has been the rating of ponderosa pine stands according to their degree of susceptibility to western pine beetle attack (16). This has been done by integrating the various factors of environmental pressure, as expressed by life zone, site, stand volume, and past losses, with present stand conditions, as shown by growth rate and percentage of beetle-susceptible trees in their composition. Forests are thus divided into five hazard zones from very low to very high, indicating the intensity of expected loss during the next critical climatic period. This zonation is highly valuable to timber

owners in determining the order or priority of their cutting program and in avoiding future loss by taking action ahead of time.

From these studies has come the realization that the native bark beetles were practicing a primitive form of silviculture in these pine stands (14), and that this system was well adapted to the growth habits of this tree and could be used as the basis for a more refined form of silviculture under man-controlled forest management. In ponderosa pine the western pine beetle was making periodic thinnings, not necessarily of the oldest and largest trees, but a "cutting from below" of slow-growing co-dominant, intermediate and suppressed trees and a thinning or clear cutting of stagnating groups. This system of cutting tended to release trees from stagnation, to make openings for regeneration, to stimulate the growth of young trees, and finally to remove the old veterans of the forest when their span of life had been run. The result was an uneven-aged forest composed of even-aged groups. Moreover, the work of these beetles was determining the natural rotation of ponderosa pine on different sites, a long rotation on good sites and a much shorter rotation on poor sites. With these clues, foresters are developing a silvicultural system for ponderosa pine which takes into account its natural habits and the part which the western pine beetle has played in its management over the centuries.

These developments illustrate how forest management of one timber type has been influenced by research in the related field of forest entomology. Intensive study of its primary insect enemy has not only gone a long way toward solving the entomological problem, but has helped point the way to proper management of ponderosa pine stands.

While we feel that this one problem has been largely solved, there are many more important forest-insect problems awaiting the same intensified research. The mountain pine beetle in lodgepole, white, and sugar pine stands; the Jeffrey pine beetle; *Ips* beetles in various pines; the hemlock looper; and the pine butterfly are a few western forest insects in which recent studies have indicated the existence of similar important silvicultural relationships. Since these insects are all native to the forests they inhabit, we may expect that in each case the solving of the biological-ecological complex will provide not only new methods of insect control through forest management, but new clues to the proper silviculture of these forest types.

Some people assume that entomology is a very narrow field and that entomologists can hardly be counted upon to do more than devise means of killing insect pests. As entomologists we know that it is an exceedingly broad science concerned in one way or another with nearly every human, animal, and plant activity, and that even our most academic researches have meaning in the ultimate solution of many highly important practical problems. I have called attention today to a contribution that entomology has made in the field of forestry. Many more opportunities still remain, not only in forestry but in nearly every other natural-science field. The possibilities of service to mankind through entomology are far from exhausted, and we entomologists still have much work to do.

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KEYS TO THE LARVAL AND ADULT MOSQUITOES OF ESPIRITU SANTO (NEW HEBRIDES) WITH NOTES ON THEIR BIONOMICS[1]

BY LIEUT. WILLIAM J. PERRY H(S) USNR[2]

Buxton, who spent four months in the New Hebrides, recorded only thirteen species during the time of his visit. At this time, even though collections were made during the dry season, indications were that a rich mosquito fauna would in all probability never be found.

A total of eighteen species was collected during the time spent by the author in the New Hebrides. Limited collections were made from the islands of Efate, Malo, Eissi, Tutuba, Aore, Malekula, and Tangoa.

These keys are based upon reared and collected material made from Espiritu Santo (New Hebrides) during a year's observations throughout the dry and wet seasons. The only anopheline found was *Anopheles farauti* Lav. which was present on all the islands of the group except Tutuba and Eissi. No attempt is made in these keys to give specific characters for identification of this species, for they are well covered elsewhere. All collections and observations were restricted to the coastal areas and none is available for elevations over 1000 feet.

Key to Fourth Instar Larvae

1. Air tube lacking; palmate hairs present on abdomen. Tribe *Anophelini*.....*Anopheles farauti* Lav.
– Air tube present; abdomen without palmate hairs. Tribe *Culicini*.....2
2. Thorax and abdomen with rosettes of short, spine-like setae; air tube with a series of single or double hair tufts dorsally. Genus *Tripteroides*.....*Tripteroides caledonica* Edw.
– Not as above.....3
3. Apical one-third of air tube much thinner and with saw-tooth projections adapted for piercing the roots of aquatic plants. Genus *Mansonia*.....*Mansonia xanthogaster* Edw.
– Air tube of cylindrical or normal shape.....4

[1]The opinions expressed in this article are those of the author and are not to be construed as reflecting the views of the Navy Department or the Naval Service at large.

[2]Department of Tropical Medicine, Naval Medical School, Bethesda, Maryland.

4. Air tube with several pairs of ventral hair tufts. Genus *Culex*.....5
– Air tube with one pair of ventral hair tufts nearly centrally placed. Genus *Aedes, Uranotaenia*.....11
5. Air tube with 12 to 16 ventral hair tufts; upper and lower head hairs single. (Siphon index 7:1).....*Culex femineus* Edw.
– Air tube with 2 to 6 ventral hair tufts; upper and lower head hairs double or multiple.....6
6. A pair of large recurved spines at tip of air tube. (Siphon index 6:1).....*Culex basicinctus* Edw.
– No large recurved spines at tip of air tube.....7
7. Upper and lower head hairs double and plumose; air tube often with a dark band medially; four pairs of rather inconspicuous ventral hair tufts. (Siphon index 8:1 to 9:1).....*Culex fraudatrix* Theo.
– Upper and lower head hairs multiple and plumose; air tube unbanded and with conspicuous ventral hair tufts.....8
8. Air tube with 4 to 6 ventral hair tufts.....9
– Air tube with 2 to 3 ventral hair tufts.....10
9. Anal gills short and bulbous; one pair of subapical hair tufts on air tube. (Siphon index 5:1).....*Culex jepsoni* Theo.
– Anal gills long and tapered; no subapical hair tuft on air tube. (Siphon index variable from 4.5:1 to 8:1).....*Culex annulirostris* Skuse
10. Air tube usually widest one-third distance from base; setae on basal ⅔ of antennae slender and tapered. (Siphon index 3.5:1).....*Culex quinquefasciatus* Say.
— Air tube tapered from base; setae on basal ⅔ of antennae stout and blunt. (Siphon index 4:1).....*Culex pacificus* Edw.
11. Air tube with apical one-third of pecten teeth more widely spaced.....12
— Air tube with pecten teeth rather evenly spaced throughout.....13
12. Upper and lower head hairs multiple; lateral comb of about 12 scales; individual comb scales not strongly chitinized and fringed around the upper half.....*Aedes funereus ornatus* Theo.
— Upper and lower hairs single or double; lateral comb of about 8 scales; individual comb scales pointed, heavily chitinized, and fringed basally.....*Aedes vexans* Meig.
13. Scales of lateral comb in a patch and arranged irregularly.....14
— Scales of lateral comb in a single row and arranged regularly.....15
14. Pecten teeth 8-9 in number; comb scales rather heavily chitinized with about 25 scales arranged irregularly in three uneven rows.....*Aedes vigilax* Skuse
— Pecten teeth 15-16 in number; comb scales rather lightly chitinized with about 50-60 scales arranged irregularly in a large yellow patch.....*Aedes raggyi* S. & B.

15. Chitinized thornlike process at the base of the ventrolateral hair tuft on the metathorax large and conspicuous.....*Aedes aegypti* Linn.
— Chitinized thornlike process at the base of the ventrolateral hair tuft on the metathorax small and rather inconspicuous.....16
16. Anal segment with sclerotic plate complete.....17
— Anal segment with sclerotic plate incomplete.....*Aedes hebrideus* Edw.
17. Individual scales of lateral comb strongly spined basally.....*Aedes pernotatus* F. & B.
— Individual scales of lateral comb without any spines or any fringe; upper and lower head hairs spike-like.....*Uranotaenia tibialis* Taylor

Key to Adult Females

1. Palpi of female as long as proboscis, or nearly so; scutellum evenly rounded; wings spotted with areas of dark scales; palpi of male long and clubbed at tip. Tribe *Anophelini*.....*Anopheles farauti* Lav.
– Palpi of female shorter than proboscis; scutellum with posterior margin distinctly tri-lobed; wings unspotted; palpi of male not clubbed at tip. Tribe *Culicini*.....2
2. Proboscis generally as long or longer than the body; dorsal apical abdominal bands usually present; a light stripe across the sides of the thorax marked with white scales, the darker parts nearly bare.....*Tripteroides caledonica* Edw.
– Proboscis shorter than the body; no dorsal apical abdominal bands; sides of thorax without such markings.....3
3. Second marginal cell less than half as long as its petiole; small species (Genus *Uranotaenia*).....*Uranotaenia tibialis* Taylor
– Second marginal cell normal, as long or longer than its petiole.....4
4. Postspiracular bristles absent.....5
– Postspiracular bristles present. Genus *Aedes*.....12
5. First hind tarsal segment shorter than tibia; large and bright orange-yellow species.....*Mansonia xanthogaster* Edw.
– First hind tarsal segment as long as tibia; dull colored species. Genus *Culex*.....6
6. Proboscis and tarsi with distinct pale rings.....7
– Proboscis and tarsi dark. (In *Culex pacificus*, the male only has a narrow ill-defined pale ring on the proboscis).....9
7. Dorsal area of vertex golden-brown, black on either side; anterior half or more of mesonotum clothed with pale scales.....*Culex basicinctus* Edw.
– Dorsal area of vertex brown to gray-brown, with a lateral triangular white patch.....8

8. Fore tibia with a row of white spots in front; dorsal, basal, abdominal bands generally produced in middle.....*Culex annulirostris* Skuse
– Fore tibia without a row of white spots in front; dorsal, basal, abdominal bands approximately equal in width, at least on segments III and IV.....*Culex jepsoni* Theo.
9. Dorsal basal abdominal bands present.....10
– Dorsal abdominal bands lacking (at least no complete bands on the first three segments).....11
10. Mesonotum dark brown and with two lines of narrow, golden brown scales forming a lyre; two pairs of black triangular-shaped markings on lateral aspect of mesonotum.....*Culex pacificus* Edw.
— Mesonotum light brown, without such markings, uniformly covered with narrow, curved, golden-brown scales; a patch of broad, pale scales low down on either side of the head.....*Culex quinquefasciatus* Say.
11. Basal lateral spots of abdominal segments somewhat rectangular; palpi of male very short, no longer than in the females.....*Culex femineus* Edw.
— Basal lateral spots of abdominal segments very small; antennae of male with modified hairs (scale-like) on segments 6 to 9.....*Culex fraudatrix* Theo.
12. Strongly ornamented species (with prominent silver markings).....13
— Dark species with little ornamentation.....15
13. Mesonotum with four silvery lines, the outer pair curved to form a lyre-shaped marking.....*Aedes aegypti* Linn.
— Mesonotum with a narrow mid-dorsal silvery line and a silvery lateral band.....14
14. Dorsal abdominal bands on segments III to VII complete.....*Aedes hebrideus* Edw.
— Dorsal abdominal bands on segments III to VII broken medially.....*Aedes pernotatus* F. & B.
15. Dorsal abdominal bands lacking.....*Aedes daggyi* S. & B.
— Dorsal abdominal bands present.....16
16. Dorsal abdominal bands median and in an inverted "U"-shape.....*Aedes funereus ornatus* Theo.
— Dorsal abdominal bands basal.....17
17. Wings with at least some white (or yellowish-white) scales.....*Aedes vigilax* Skuse
— Wings entirely dark scaled.....*Aedes vexans* Meigen.

Anopheles (Myzomyia) farauti Laveran

Larvae: Dry season breeding places for *farauti* in the New Hebrides consist primarily of rivers, streams, springs, seepage areas, ponds, taro gardens under water, swamps, and open wells located near native plantations.

During the rainy season, breeding may occur in almost all the additional water collections which form. At this time larvae may be found in all types of natural and man-made catchments, such as ruts, foxholes, bases of uprooted trees, borrow pits, poorly graded ditches, and in such places as hog wallows and occasionally in coral pools above the high tide level. Larvae are rather commonly discovered in such artificial containers as large tin cans, empty gasoline and oil drums, watering troughs, tubs, and occasionally in beached boats. The water in the above-mentioned types of breeding places may be clear, turbid, somewhat stagnant, brackish, or pure rain water. In nearly all cases, breeding in extensive water areas is associated with flotage or emergent vegetation. However, in small confined places such as pools, puddles, and road ruts larvae will commonly be found on the open surface, without any surface obstructions.

Larvae are rarely collected in coconut halves, tree holes, or in the axils of water-holding plants. Occasional ones have been reported in small tin cans and in coconut halves which were subject to flushing with rain water; however, this type of breeding place is the exception rather than the rule. Larvae were easily collected in swamps or pot holes that contained lodged mats of floating duckweed (*Lemna*). When the plants were scattered, a few were reported, but pools remained consistently free of anophelines in heavily covered pond surfaces.

Adults: Readily attack man. Most important anopheline as a vector of malaria and filariasis in the New Hebrides-Solomon Islands. Diurnal resting places consist of native huts, darkened quarters of military personnel, and tree buttresses in shaded jungle areas.

Tripteroides (Mimeotomyia) caledonica Edw.

Larvae: These rather unusual looking larvae are found primarily in tree holes, axils of pandanus trees, sago palms, and banana-like plants. They are also found in coconut halves and husks, bamboo stumps, and artificial containers such as tin cans, sagging tent covers, tarpaulins, and wooden frames holding water.

The larvae have a woolly appearance due to numerous spine-like setae on the thorax and abdomen. There is a marked variation in the length of the air tube and also in the chaetotaxy of the abdomen of the larvae and pupae of this species.

Adults: The adults have not been collected while biting man. They are collected freely resting on tree trunks.

MANSONIA (COQUILLETTIDIA) XANTHOGASTER EDW.

Larvae: The larvae and pupae of this interesting genus have a peculiarly adapted air tube modified for piercing the roots or stems of aquatic plants.

On Espiritu Santo they are collected primarily from aquatic plants in large permanent fresh water swamps. *Mansonia* larvae and pupae have been collected in the field from several types of aquatic plants, but have been recorded most abundantly attached to the roots of the small clump-like *Pandanus*. In the laboratory they have been observed attached to the slender stems of certain floating plants such as duckweed (*Lemna*) and to the fleshy roots of the white water lily (*Nymphaea*).

Adults: Adults rest primarily on vegetation near the immediate vicinity of their breeding sites. They are persistent and vicious biters particularly near breeding areas. They bite during the day and early morning hours.

URANOTAENIA TIBIALIS TAYLOR

Larvae: The aquatic forms are collected in grassy swamps, densely shaded jungle swamps, the overflow of streams, and shallow pools formed along receding streams.

These larvae resemble anopheline larvae in their resting positions at the surface of the water. They are readily identified by their long spike-like head hairs.

Adults: Adults rest on tree buttresses and overhanging stream banks in the jungle. They are not known to bite man.

CULEX (MOCHTHOGENES) FEMINEUS EDW.

Larvae: The larvae of this species are most frequently found in rock pools along the sides of streams. They have occasionally been reported breeding in abandoned road ruts, open native wells, and partially submerged oil drums. One report has been made of its breeding in a tree hole. This is a fairly abundant species where favorable larval habitats occur.

Adults: Adults are collected at will resting upon tree trunks and moist overhanging banks. They are not known to bite man.

Culex (Culex) basicinctus Edw.

Larvae: This species is a rather rare mosquito in the New Hebrides. The larvae are found in association with various types of *Spirogyra*. They have been collected among algae along river margins and in the ox-bows of rivers formed during the dry season. The apico-dorsal hairs on the air tube are modified to form stout recurved spines which are used in clinging to the filamentous mats.

Adults: Adults have not been collected attempting to bite man. Because of restricted breeding areas, adults are difficult to collect in nature.

Culex (Lophoceratomyia) fraudatrix Theo.

Larvae: These larvae have been found in shaded areas in permanent swamps among the roots of trees, along shaded, grassy stream margins, and occasionally in rocky pools and abandoned road ruts. The air tube of the larva is very long (9:1) and the ventral hair tufts are small and rather inconspicuous. Occasionally a dark median band is present on the air tube.

Culex hilli buxtoni and *Culex fraudatrix* are now considered to be synonymous.

Adults: Adults do not attack man readily. They are easily collected in the vicinity of breeding areas resting on vegetation, tree trunks, and overhanging protected stream banks.

Culex (Culex) jepsoni Theo.

Larvae: In the New Hebrides the larvae of this species are found most characteristically in water collections in coral or sand pockets formed above high tide level. Reports have been made of its breeding in barrels and tin cans along beaches, in rain puddles, and in brackish water ditches. This species is characateristically coastal in distribution and where locations are found favorable for breeding, the larvae are very numerous.

Australian records of *Culex sitiens* are considered to belong to *Culex jepsoni*.

Adults: Adults have not been collected biting man.

Culex (Culex) annulirostris Skuse

Larvae: These common larvae are taken in sunny areas of permanent swamps, road ruts, ditches, ponds, hog wallows, bases

of uprooted trees, and other natural catchments. They are seldom taken in confined places like tin cans, tree holes, or coconut shells. The length of the air tube varies from 4.5:1 to 8:1. Usually larvae taken from swamps and ponds containing relatively fresh water and abundant duckweed (*Lemna*) possess a noticeably slender air tube with an index close to 8:1. Those commonly collected in road ruts and other temporary ground pools and catchments possess a short tube with a siphon index of 4.5:1 to 6:1.

Adults: Adults attack man readily in the late afternoon and evening, and occasionally in the shade during the day. This species is the most common mosquito taken in routine night catches.

Culex (Culex) quinquefasciatus Say.

Larvae: This species is primarily a domestic mosquito. The larvae are found in various artificial receptacles near plantation homes and native huts. The larvae of *Culex quinquefasciatus* and *Culex pacificus* resemble each other very closely and are often difficult to separate from one another.

Adults: Adults bite readily at night. They rest primarily in quarters of military personnel and in native huts. In nature large numbers have been collected resting in tall grass and other emergent vegetation in the breeding area.

Culex (Culex) pacificus Edw.

Larvae: Larvae are primarily found breeding in tree holes and cavities holding water. They are commonly collected in tin cans, artificial containers, and ocacsionally in coconut shells and plant axils. This is a rather abundant species.

Adults: Adults apparently do not attack man.

Aedes (Aedes) funereus ornatus Theo.

Larvae: These larvae are found in temporary rain pools, road ruts, hog wallows, and occasionally in ditches. They are often found in association with larvae of *Aedes vexans*. It is not a common larva considering how infrequently the adults are seen.

Adults: Adults attack man readily in jungle areas. This species is one of the most vicious day biters.

Aedes (Aedimorphus) vexans Meigen

Larvae: Larvae are usually collected in temporary rain pud-

dles but are occasionally found in grassy swamps and drainage ditches following rains.

Adults: Adults attack man readily in the vicinity of breeding areas.

Aedes (Geoskusea) daggyi Stone and Bohart

Larvae: To date these larvae have been collected from crab and lobster holes near fresh water swamps or in brackish water near the ocean. This is a difficult larva to find and may be easily overlooked due to its light appearance and habit of remaining submerged for long periods of time. Occasional ones have been collected from temporary ground pools, probably due mainly to the flooding of crab and lobster holes during periods of heavy rains. There appears to be a fresh and a salt water variety. *Daggyi* is commonly taken in crab holes located near the ocean.

Adults: Adults are not known to bite man.

Aedes (Stegomyia) aegypti Linn.

Larvae: This well known domestic mosquito is usually found in artificial containers near plantation homes and native villages. It is very common in rain barrels, buckets, and most any kind of artificial container. They have been recorded in large numbers breeding in salvaged tire casings.

Adults: Adults attack man readily and are well known for their bloodsucking habits. This species is the important vector of dengue in the New Hebrides.

Aedes (Stegomyia) pernotatus F. & B.

Larvae: The larvae are occasionally found with *hebrideus* breeding in water held in wooden frames or coconut husks, but they are also found in tree holes and tree cavities. The larvae are not as abundant as *hebrideus* which they closely resemble.

Adults: Adults were not collected biting man in nature. They are reluctant to feed even under insectary conditions, although occasional ones have been induced to take a human blood meal.

Aedes (Stegomyia) hebrideus Edw.

Larvae: This is a common larva found in tree holes, coconut husks and shells, sagging tents and tarpulins, wooden frames, rain barrels, and artificial containers of all types.

Adults: Adults attack man readily and are persistent biters during the day.

AEDES (OCHLEROTATUS) VIGILAX SKUSE

Larvae: This is a salt and brackish marsh species. Larvae were collected by the author on one occasion in 1944 on Espiritu Santo from a salt water pool located above high tide level. This one collection probably represented an introduction from Noumea, New Caledonia, for it is not generally distributed in the New Hebrides. This was the first positive record of its presence in the New Hebrides.

Adults: Adults attack man readily during the day and are vicious and annoying biters.

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LONGEVITY OF TRICHODES AND PELONIUM LARVAE

Recently a number of clerid larvae were examined which had been collected in 1940 and 1941 in connection with a study of the life history of *Trichodes ornatus* Say[1]. One example, taken as a fifth instar larva from the cells of *Odynerus blandinus* Cresson on December 24, 1940, completed its development and transformed to an adult between April and September, 1945, after a larval life of at least five, and possibly six, years, the period since 1940 having been spent without food. A second larva, which last accepted food on June 30, 1941, transformed in the same period after a larval life of four years. A third individual is still alive after four years and seven months, having spent the last four years and five months without food (in the fourth, fifth, and sixth larval instars). A larva from a nest of *Hoplitus productus* (Cresson), previously reported[1] as *Trichodes ornatus*, completed its development between April and September, 1945, and proved to be *Pelonium fasciatum* (Lec.) (det. W. F. Barr). It had been collected on August 10, 1939, and had accepted no food in the interim.—E. G. LINSLEY and J. W. MACSWAIN.

[1] Linsley, E. G. and J. W. MacSwain, 1943. Observations on the life history of *Trichodes ornatus* (Coleoptera, Cleridae), a larval predator in the nests of bees and wasps. Ann. Ent. Soc. Amer., 36:589-601, 2 pls., 1 t. fig.

NOTES ON CUBAN TRIATOMINAE
(Hemiptera, Reduviidae)

BY ROBERT L. USINGER
U. S. Public Health Service

During a recent visit to Cuba types and other specimens of Triatominae were examined. My work was greatly facilitated by the generous assistance of Dr. S. C. Bruner of the Estación Experimental Agronomica at Santiago de las Vegas and Dr. J. M. Osorio of the University of Havana. Thanks are also due to the directors of the Instituto de Segunda Ensenanza de la Habana for admitting me to the "Museo Gundlach."

Bolbodera scabrosa Valdés

The type, No. 385, in the Gundlach collection, is well preserved but the red color has faded to pale yellow and the hemelytra are broken apically.

Nesotriatoma flavida (Neiva)

A specimen, No. 88, is preserved in the sealed, glass covered box in the Gundlach collection. It is labeled *Rhodnius prolixus* Stål (presumably a Uhler determination) and is undoubtedly the source of subsequent records of *Rhodnius prolixus* for Cuba. The specimen is relatively large (approaching the type of *bruneri* Usinger in this respect) with a short, equilateral pygidium and with the first antennal segment reaching almost to apex of clypeus.

At the suggestion of S. C. Bruner all available specimens of *Nesotriatoma* Usinger were studied to determine limits of variation. Although no specimens were available from Western Cuba, variations between *bruneri* and *flavida* were found in Dr. Bruner's series of 9 specimens from Central and Eastern Cuba. The size of eyes and degree of development of tibial fossae proved to be valueless as diagnostic characters within this plastic group. Two female specimens from the western part of Camaguey Province (Majagua and Is. Turiguaro) had relatively short first antennal segments and relatively long pygidia in contrast to seven specimens from the vicinity of the city of Camaguey and from Oriente Province.

Ten specimens from the vicinity of Camaguey, all in the University collection of Dr. Osorio, ranged in size from large females like the type of *bruneri* to a male 22 mm. long which resembles closely the type of *flavida*. Under the circumstances *Nesotriatoma bruneri* Usinger must be considered as a straight synonym of *Nesotriatoma flavida* (Neiva).

It is interesting to speculate on the probable native hosts of these bugs on an island with such a depauperate mammalian fauna as Cuba. The commonest group of native animals is the rodent genus *Capromys* and Dr. Bruner (*in litt.*) states: "It appears to be more than a probability that the common short-tailed hutia or *jutia conga, Capromys pilorides* (Pallas), is the native host of *Nesotriatoma flavida*. It seems likely that the smaller, long-tailed, arboreal *jutia andaroz* of eastern Cuba, *Capromys melanuras* Poey, may be a host of the *Bolbodera*."

The genus *Capromys* is restricted to Cuba, the Isle of Pines and adjacent keys whereas the closely related *Geocapromys* occurs in the Behamas, Jamaica, and Little Swan Island. The Venezulan *Procapromys* extends the range of this group to the South American mainland. The two genera of bugs under discussion have been reported only from Cuba. *Bolbodera*, however, is related to *Belminus*, a genus which has been recorded from sloths in Costa Rica. The endemic sloths of Cuba are now extinct but *Bolbodera* may be a relic, surviving on other animals since the death of its last original host.

A NEW TEXAN LITHOBIUS
(Chilopoda)

BY RALPH V. CHAMBERLIN
University of Utah, Salt Lake City

The new species of Lithobius here described is represented by a single adult female in a small collection of myriopods taken in a nest of *Neotoma micropus* by Maj. D. E. Hardy. The genus *Lithobius*, as now restricted, is not a large one in its American representation, so that the addition of another species is a matter of interest. It may be placed with reference to the other known North American species by means of the following key:

Key to American Species of Lithobius

a. None of the coxae laterally armed.....*L. forficatus* (Linne)
aa. Coxae of last three pairs of legs laterally armed.
b. Anal legs with the claw single.
c. Penult legs with the claw single.
d. Ventral spines of anal legs, 0, 1, 3, 3, 2; dorsal spines of 13th legs, 1, 0, 3, 1, 1,.....*L. atkinsoni* (Bollman)
dd. Ventral spines of anal legs 0, 1, 3, 3, 1; dorsal spines of 13th legs, 1, 0, 3, 2, 2.....*L. hardyi* new species
cc. Penult legs with 3 claws.....*L. celer* Bollman
bb. Anal legs with two claws.....*L. chumasanus* Chamberlin

Lithobius hardyi Chamberlin, new species

Dorsum in the type uniform brown; antennae brown, lighter distally; legs pale.

Antennae moderately long; the articles also moderately long and 32-34 in number. Eyes elliptic, with ocelli in four series—1+5, 7, 5, 5 (4).

Prosternal teeth 6+6, the median incision deep and narrow.

Ninth, eleventh and thirteenth dorsal plates with posterior angles produced.

Coxal pores circular, 6, 6, 6, 5.

Ventral spines of the first legs, 0, 0, 2, 3, 2; the dorsal, 0, 0, 3, 2, 1. Ventral spines of the penult legs, 0, 1, 3, 3, 2, dorsal spines, 1, 0, 3, 1, 1; the claw unarmed. Ventral spines of the anal legs, 0, 1, 3, 3, 1, dorsal spines, 1, 0, 3, 1, 0; claw unarmed. Dorsal spines of the thirteenth legs, 1, 0, 3, 2, 2. Last four pairs of coxae dorsally armed, the last three also laterally armed.

Claw of the genital forceps tripartite; basal spines 2+2, long and gradually acuminate.

Length, 20 mm.

Locality. Texas: Laguna Madre, 23 miles southeast of Harlingen. One female taken in the nest of *Neotoma micropus* Baird, September 26, 1945, by D. E. Hardy.

This species is most closely related to *L. atkinsoni* Bollman, known from Georgia and the Carolinas. It is a larger species differing also, *e.g.*, in having the ventral spines of the first legs 0, 0, 2, 3, 2, as against 0, 0, 1, 2, 2, or 0, 0, 1, 2, 1, the dorsal spines of the thirteenth legs 1, 0, 3, 2, 2, as against 1, 0, 3, 1, 1, and the ventral spines of the anal legs, 0, 1, 3, 3, 1 as against 0, 1, 3, 3, 2.

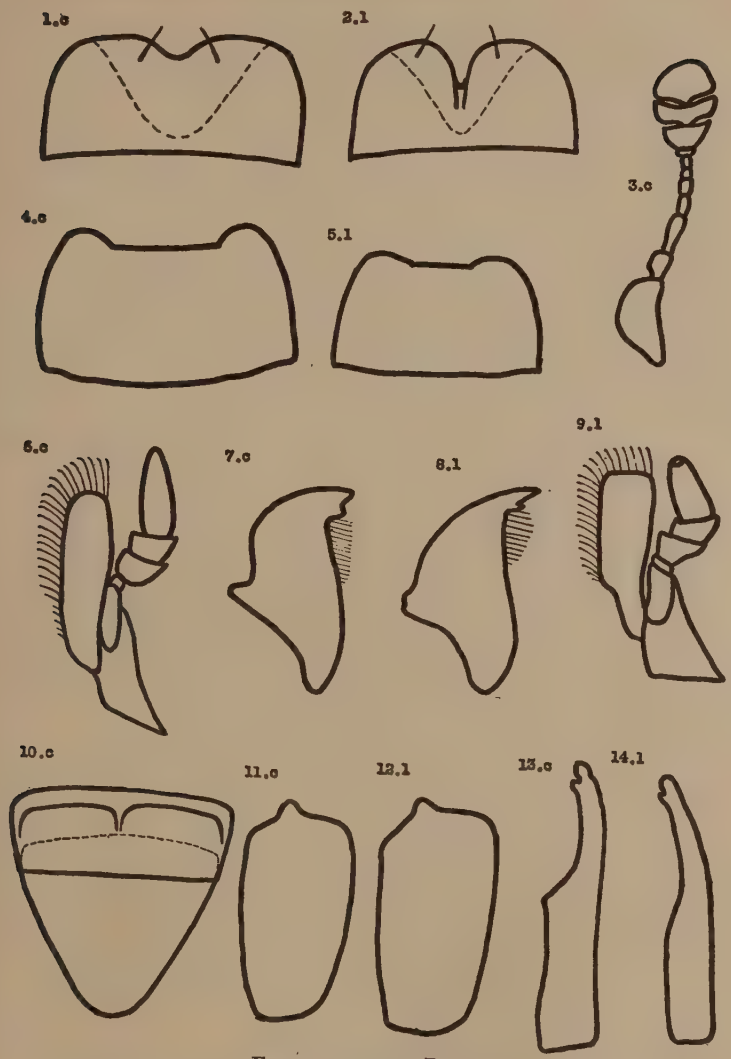
A NEW SPECIES OF NITIDULID BEETLE

BY L. R. GILLOGLY
State Department of Agriculture, Sacramento, California

Dried Fruit Beetles are of considerable importance in the processing and storage of certain California agricultural products. Aside from lowering the quality by their presence in the products they cause much spoilage by carrying molds and ferments from infected to sound products. The beetles most frequently found in drying or rotting fruit belong to the genera *Carpophilus* and *Haptoncus*. Until recently we have known of only one species of the latter genus in our California fauna, namely *H. luteolus* (Erich.). This species is widely distributed through the principal agricultural regions of California. During the last two years I have been finding darker colored specimens, referable to *Haptoncus*, in decaying and mummied oranges. These represent a previously undescribed species, and the purpose of this article is to give this species a name. The new species is known only from coastal southern California.

Haptoncus californicus Gillogly, new species

Oval, slightly oblong, shining, sparsely pubescent, uniformly rufo-piceous except for black eyes. Head moderately coarsely punctate. Prothorax with width to length as 2 to 1, sides feebly arcuate, narrowing anteriorly, hind angles rectangular, hind margin bisinuate, sides densely coarsely punctate becoming sparsely punctate on disc. Elytra with length slightly less than width conjointly, narrowed posteriorly, apices obliquely truncate, surface more coarsely and sparsely punctate than prothorax. Abdomen, dorsum of penultimate segment with a deeply impressed, semi-circular, transverse line on each side, giving appearance of spine at middle. Middle tibiae simple in both sexes. Posterior tibiae of male suddenly dilated, distal half twice as wide as apical portion, a distinct, slightly prominent, obtuse angle formed at midpoint. Labrum truncate, feebly emarginate, chitinized portion broadly U-shaped. Mandibles toothed, blunt. Maxillae; lacinia, oblong, somewhat rounded at tip; palpus, first segment minute, second segment large its outside outline strongly arcuate, third segment large, sides slightly arcuate, fourth segment elongate, conical, truncate, sides very slightly arcuate. Length, 2.2 mm.



Explanation of Plate

Haptoncus californicus: 1.c labrum; 3.c antenna—not significantly different from that of *H. luteolus*; 4.c prothorax; 6.c maxilla; 7.c mandible; 10.c pygidium and penultimate dorsal segment; 11.c elytra; 13.c posterior tibia of male.

Haptoncus luteolus: 2.1 labrum; 5.1 prothorax; 8.1 mandible; 9.1 maxilla; 12.1 elytra; 14.1 posterior tibia of male.

Adults easily separated from *H. luteolus* by their dark color. Sometimes taken with *H. luteolus* in decaying oranges, but usually found in the mummied fruit. Specimens were collected from December to April in southern California (Pasadena, San Marino, Anaheim, Orange, Irvine, San Dimas, La Habra). All specimens were collected by the author.

Holotype and *allotype* from SAN MARINO, CALIFORNIA, March 11, 1942, placed in the California Academy. *Paratypes*: California Academy of Sciences, California State Department of Agriculture, Los Angeles County Museum, American Museum of Natural History, U. S. National Museum, Museum of Comparative Zoology Harvard University, and in the author's collection.

COMPARATIVE TABLE

	Haptoncus californicus	*Haptoncus luteolus*
Shape:	oblong oval	same
Color:	rufo-piceous	testaceous
Punctation:	coarse, sparse	same
Prothorax:	width to length as 2 to 1	1.9 to 1
	posterior margin bisinuate	sinuate
Elytra	apices obliquely truncate	squarely truncate
Abdomen:	penultimate segment transversely impressed	simple
Hind tibia of male:	dilated	same
	prominently angled at midpoint	evenly arcuate
Labrum:	truncate	rounded
	feebly emarginate	bilobed
	chitinized portion broadly U-shaped	V-shaped
Mandibles:	bluntly toothed	teeth sharp
Maxillae:		
lacinia	oblong, somewhat rounded at tip	oblong tip truncate
palpus	first segment minute	small
	second segment large, outside outline strongly arcuate	outline sinuate
	third segment large, sides slightly arcuate	same
	fourth segment elongate, conical, truncate, sides very slightly arcuate	shorter, sides more strongly arcuate

SOME NEW SPECIES OF NORTH AMERICAN SATYRIDAE
(Lepidoptera)

BY ROBERT C. WIND
Berkeley, California

In the Big Bend country of southwestern Texas lies a region which has been but little worked by Lepidopterists. In the heart of this region are the Chisos Mountains, an interesting semi-desert range of isolated peaks. I heard that two friends, Mr. Arthur Smith and Mr. Edgar Smith were driving through this area during the summer of 1941. They kindly consented to stop in the Chisos for a few days to do some collecting.

Now that the material they collected has been mounted and studied, it appears that several species of Satyridae have developed distinct races in the Chisos Range.

MINOIS MEADII (EDWARDS)

Erebia meadii Edwards, 1872, Trans. Amer. Ent. Soc., 4:70. (Originally found near Bailey's Ranch, 45 miles from Denver, Colorado. Specimens in my collection range from the Dakotas to New Mexico, and the range possibly extends into Texas.)

Cercyonis damei Barnes & Benjamin, 1926, Bull. So. Calif. Acad. Sci., 25:90. (From Grand Canyon, Arizona. This appears to be a subspecies of *meadii*, and not a full species as described.)

Minois meadii melania Wind, new subspecies

Male: forewing dark brown with two small ocelli, placed as is usual in the group. The apical ocellus larger and with a small white pupil. The lower ocellus small with no pupil. Surrounding each ocellus is a narrow russett halo, not diffused as in *meadii*. Hindwing dark brown with a small, white-pupilled ocellus in the lower median interspace. Underside of forewing as in *meadii*, but with lower ocellus smaller than apical. Russett coloring widespread in contrast to upper surface. Hindwing beneath as in *meadii* except that there are two apical ocelli. *Female*: forewing light brown with two equally large white-pupilled ocelli; russet coloring spread almost entirely over the wing, entering the cell. Hindwing light brown with a well-defined white-pupilled anal ocelli. Underside with russet coloring reaching almost to base in forewings, and hindwings with all usual ocelli sharply defined and in addition two well-formed, white-pupilled apical ocelli.

Holotype male from MARFA ALPINE, TEXAS, July 17, 1941, and *allotype* female from CHISOS MOUNTAINS, TEXAS, July 19, 1941, in the collection of the author. Two male and three female *paratypes* from Marfa Alpine and one male and one female paratype from Chisos Mountains, same dates, all collected by Arthur and Edgar Smith. One pair deposited in the California Academy of Sciences, one pair in the Canadian National Collection, one female in the Museum of Comparative Zoology, one female in the U. S. National Museum, and one pair in the collection of Arthur and Edgar Smith.

Male *melania* differs from *meadii* in the following particulars: much darker than *meadii*, with russet coloring restricted above yet more pronounced beneath. None of my *meadii* show apical ocelli on the hindwing beneath, while all *melania* have two apical ocelli. Female *malania* differs in its larger size, lighter coloring, and heavier russet suffusion as well as in the more pronounced ocelli and the addition of the two apical ocelli of the hindwing beneath.

Megisto rubricata smithorum Wind, new subspecies

Differs from *rubricata* (Edwards) in the distribution of the rust colored areas of the fore and hindwings. In typical *rubricata* from Arizona the rust colored area of the forewing barely reaches to the cell, while in smithorum this rust area enters the cell and covers nearly half of the cell space. The hindwings show just the opposite characteristic: the rust area of *rubricata* being of equal size to that on the forewings, while in smithorum this color has become almost obsolete, especially in the male. M. smithorum also has larger ocelli than *rubricata*, and all the markings beneath are more sharply defined.

Holotype male, MARFA ALPINE, TEXAS, July 17, 1941, and *allotype* female, CHISOS MOUNTAINS, TEXAS, July 18, 1941, in the collection of the author. Four male and three female *paratypes* from Marfa Alpine and two male and three female paratypes from Chisos Mountains, same dates, all collected by Arthur and Edgar Smith. One pair deposited in the California Academy of Sciences, one pair in the Canadian National Collection, one pair in the U. S. National Museum, one pair in the Museum of Comparative Zoology, one pair in the collection of Arthur and Edgar Smith, and one pair in the collection of the author.

I take pleasure in naming this subspecies in honor of its collectors, Messrs. Arthur and Edgar Smith.

NEONYMPHA HENSHAWI (EDWARDS)

Euptychia henshawi Edwards, 1876, Trans. Amer. Ent. Soc., 5:205. (First taken by H. W. Henshaw on the Wheeler expedition and recorded from Arizona, New Mexico, and Colorado.)

Neonympha henshawi texana Wind, new subspecies

This new subspecies differs from *henshawi* in a number of particulars. As only males are available, the following observations relate to that sex only.

Consistently smaller than *henshawi*. Above, the color is much darker and the sexual scale patch on the forewing is heavier. This scale patch is far more conspicuous than in *henshawi* as it is outlined by russet scales. The two black spots on the margin of the hindwing are not as prominent as in *henshawi*. Underneath the difference is remarkable in that the colorings are enriched to such an extent as to give a tropical appearance to the insect. The ground color of both wings is a rosy russet instead of a yellow russet as in *henshawi*. The forewing is crossed by two wavy red lines enclosing the median area, and by a third submarginal line. The two median lines extend across the hindwing where they are wider and darker. These lines are much heavier and more richly colored than in *henshawi*. The oval patch on the middle of the hind margin is enlarged and of a beautiful silvery-gray color. The silver lunules along the margin of the hindwing are heavier and more brilliant than in *henshawi*.

Holotype male from MARFA ALPINE, TEXAS, July 17, 1941, in the collection of the author. Three male *paratypes*, with similar data, all collected by Arthur and Edgar Smith. One male deposited in the collection of the California Academy of Sciences, one in the Canadian National Collection and one in the collection of Arthur and Edgar Smith.

It is hoped that female specimens may soon be obtained for description, although it is likely that they are much like the male.

APROPOS C. V. RILEY

BY DAVID MILLER
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When searching for data in the preparation of "A History of New Zealand Entomology," I came across the following episode regarding C. V. Riley. It seems that this has not been recorded before. In view of the interest to United States entomologists, I present it here; thus it will reach a much wider range of readers than if issued merely in the historical work under preparation.

In the seventies and eighties of last century the farming community of New Zealand awoke to the fact that many insect aliens were playing havoc with crops. One finds many references to this state of affairs, which during the early nineties culminated in a combined effort by the farming community throughout the country to secure government action in the appointment of a fully qualified entomologist. There were many prominent New Zealand amateurs at that time—W. M. Maskell, C. M. Wakefield, R. Allan Wight, all of whom took an interest in entomological problems—but no professionals.

What led to the subject of this present memoir was that I came across a statement to the effect that the government of that period was negotiating with a prominent entomologist in order to secure his services. Further than this I could find nothing until I unearthed, from the old archives of the New Zealand Department of Agriculture, a file which showed that this prominent entomologist was none other than C. V. Riley; and I must here express my indebtedness to the Director General of Agriculture (Mr. M. J. Fawcett) for giving me access to this and other records of historical importance.

The following is the sequence of events regarding Riley as I found them recorded. On 28th July, 1894, the Secretary of Agriculture (the late John D. Ritchie) recommended that Riley should be communicated with in order to seek his assistance in securing a thoroughly good man for the position of Government Entomologist in New Zealand, since the need was "becoming every year more necessary." Eventually, on August 3rd, a request was sent to Riley asking him to suggest someone, preferably a man trained under Riley himself.

Writing from the United States National Museum, Washing-

ton, Riley replied on 5th November, 1894, stating that he had received the communication upon his return from a recent trip to Europe, and that he was mortified concerning his absence having caused delay in replying. Regarding the subject of the communication, he pointed out that he would have been better able to answer the enquiry had a specific sum been mentioned as the salary offered; and that he could not call to mind anyone, deserving recommendation, who was free, so that more enducement would be required to secure the services of a good man. "In other words, it is largely a question of salary."

Continuing, he presumed that the New Zealand authorities were aware that he had felt constrained, the previous June, to resign from his own position of Government Entomologist to the United States Department of Agriculture. Being free, therefore, he stated that he might be induced to come to New Zealand himself under certain circumstances; in view of this he asked whether the New Zealand Government would consider inviting him, and, if so, what the salary limit would be.

On 19th February, 1895, the New Zealand Government replied to Riley's memorandum of November 5th, and offered him a salary of £300 per annum(!) plus 12/- per day allowance when travelling on entomological work in New Zealand. Replying to this offer on 21st June, Riley acknowledged having received the communication whilst in California, and that he had just returned from a trip to Europe where he had purposefully interested himself in matters other than entomology owing to ill health. He then stated that if the salary offered were raised to £600 per annum he would agree to accept the position for a year, and that the 12/- per day field allowance would be acceptable.

On 5th November the New Zealand Secretary of Agriculture recommended to his Government that £500 be offered, though he, himself, expected that Riley would not accept less than £600. However, this offer was never despatched. On November 12th the Secretary noted on his documents that he had read a cable item in the newspapers announcing Riley's death. And so the matter closed!

Though death put a period to Riley's coming to New Zealand, this country had derived considerable benefit through his assistance. One of the outstanding figures (though an amateur) in New Zealand applied entomology during the eighties and nineties was R. Allan Wight of Paeroa, who corresponded with Riley

and secured valuable advice from him on the identity and control of many alien insects plaguing the farmers in this country. Furthermore, Wight played a prominent part in assisting Riley to secure *Novius cardinalis* in New Zealand for shipment to California, and had accompanied Koebele in his search for the ladybird during his sojourn here.

Not unmindful of Wight's activities, and, overlooking the generous aid Riley, himself, had already extended to New Zealand, the latter yet felt constrained "to return the favours received from Australia and New Zealand by sending some of the natural enemies of the codlin-moth, and from last accounts, though jeopardized by the action of the custom's-house authorities, the experiment promised success so far as species of *Raphidia* from California is concerned." And, further, he also endeavoured "to introduce some of the parasites which attack the Hessian-fly in Europe and which do not occur in this countrȳ" (i.e. the United States).

In conclusion. One cannot help but dwell on the developments that would have taken place here with Riley's guidance. I feel that one year would not have contented him once he set foot in this land. It is certain that Riley's untimely death was most unfortunate for us, and there can be no doubt but that a first rate entomological service would have been built up by him. As it turned out, it was not until February, 1916, 21 years after the abortive negotiations with Riley had taken place, that there was any definite action by the New Zealand Government to appoint a full-time entomologist to the Department of Agriculture. This was when I was engaged to undertake a special investigation; an appointment that later became that of Government Entomologist. Thus our entomological service belatedly emerged as a unit in applied research.

Recalling the uphill climb in the early days of my first appointment, when one had to depend on one's own resources, it is a simple matter to realize what it would have meant had the opportunity been available for a sound entomological training under a man of Riley's attainments. And finally, from this personal thought emerges another, to-wit: had Riley been in New Zealand it is most likely that he would have been the means of advising my father against refusing the late Dr. S. W. Williston's invitation to me in 1907 to study under his aegis in the United States.

PACIFIC COAST ENTOMOLOGICAL SOCIETY

F. P. KEEN, *President* E. G. LINSLEY, *Secretary*
C. D. DUNCAN, *Vice-President* R. C. MILLER, *Treasurer*

PROCEEDINGS

One Hundred and Eighty-fifth Meeting

The one hundred and eighty-fifth meeting of the Pacific Coast Entomological Society was held at 2:00 P.M. on March 17, 1945, in the entomological laboratories of the California Academy of Sciences, San Francisco. The following members were present: R. C. Miller, E. G. Linsley, A. E. Michaelbacher, E. O. Essig, E. C. Van Dyke, P. Moorhead, R. W. L. Potts, M. W. Allen, and R. F. Smith. Visitors were present as follows: H. L. Mason, O. G. Bacon, and J. E. Ryus.

The minutes of the previous meeting were read and approved.

The chairman called for notes and observations from members. R. F. Smith reported the capture of 20 or more adult *Colias eurytheme* flying in Tesla Canyon in March. This observation was of special interest as an indication that the species overwinters in the foothill areas. He also called attention to the capture of a Proturan in Marsh Creek Canyon, Contra Costa County, Calif.

Dr. Miller then presented Prof. H. L. Mason, curator of the University of California Herbarium, who addressed the Society upon the "Nature and Causes of Floristic Zones", a summary of which follows:

The tendency of the vegetation of any particular area, large or small, to assume certain characteristics by which it might be described and become known has lead to many theories of attempted explanation. We hear of so-called climatic zones and their vegetation, of life zones, of vegetation zones, edaphic areas, and a complete hierarchy of communities and associations of plants aimed to express graduated values of environmental factors or relationships of one sort or another. More recently we have seen special definitions of floras and their component elements aimed at historical concepts of floristic evolution. Many of these explanations assume climatic boundaries. It may be of interest to discuss some of these problems to determine, if possible, if there may not be some dynamic foundations for their existence.

One of the major causes of the diversity of vegetation on the earth is climate. We are all aware of the limitation climate places

on the type of crops any area can produce. We likewise sense, even if we cannot define precisely, the role of climate in the occurrence of some of the major floristic areas within the experience of each of us. There is the desert with its special climate and flora, the fog belt and its redwood forest, the fog desert and its flora, the fog tundra and its lichen flora, the rain forests and any number of other vegetation types that are commonly associated with climatic conditions. For purposes of defining such areas and studying their causes our attention is naturally directed to their boundaries. What are the climatic limits of the flora and are the boundaries reasonably sharp? Can they be defined as boundaries? Before we attempt to consider these questions, let us briefly review a floristic situation with which all of you are more or less familiar. That is the zonation of vegetation of the Sierra Nevada.

The Sierra Nevada have provided a classical example of the horizontal banding of vegetation. These bands are most frequently spoken of as life zones and comparisons have been drawn between these and zones of latitude with the intended object of drawing parallels of a climatic nature as causes of the zonation. To most people it seems obvious that the cause of this zonation must be climatic just as the causes of the desert, the rain forest and the tundra are climatic. But just to give you something to think about, let me ask: What about the boundaries? Are they climatic? How about this rather abrupt change from the Upper Sonoran Digger pine—blue oak forest to the Transition yellow pine—sugar pine forest? Does that represent a climatic break? The boundary between higher zones? Timber line? Between the Sierran forest and the Great Basin sage brush? Are these all climatic boundaries between vegetation zones that owe their existence to climate If so, what is the nature of a climatic boundary? Obviously, I am asking more questions than I can answer.

The meterologist will tell you that any aspect of climate is represented spatially by a gradient. Ideally, climate between the equator and the poles is a gradient in which there are no climatic zones in the sense that they have boundaries. The tropics of Cancer and Capricorn, the Arctic and Antarctic circles, are all boundaries of solar phenomena that are not necessarily related to climate. They do not set off climatic areas. The moisture-temperatus features of the Sierra Nevada are represented by a gradient from one place to another and at no point can one say here is a climatic boundary. Yet we have vegetation zones in the Sierra Nevada that conform to altitude and the only environmental variables that we have in the Sierra Nevada that consistently fluctuate with altitude are those associated with climatic factors.

Climate is the interaction of insolation and the surface features of a rotating earth and its atmosphere. Insolation is reasonably constant so that in any given area its chief fluctuation is due to movement of the earth in the ecliptic and we have as a result a

seasonal progression of insolation. Within the seasons there is also a diurnal progression. The features of this progresion are relatively uniform as is exemplified by the characteristic climatic features of the seasons and of night and day. Likewise, the rotation of the earth is constant. The other two factors are very variable in so far as their effect on climate is concerned and the precise nature of the atmosphere climatically is the direct result of the other three. The surface features of the earth, however, play a very important part in variation in climate from one place to another as well as in its local constancy. The presence of large bodies of water, extensive land areas, mountain ranges, all play a part in the pattern of climate over the earth and hence serve to control, in a sense, the vegetation of these areas. When we cross the Sierra Nevada, we suddenly leave a heavy coniferous forest and enter a region of bleak sagebrush. In order to witness this, we go up over a mountain range. This self same mountain range is alike the cause of the climatic condition that enables the dense forest to grow on its slopes and prevents it from occupying the area of the sagebrush.

In a region like Yosemite, we witness, in a short horizontal distance of about 4000 feet of vertical distance from the valley floor to Glacier Point, a climatic and floristic difference that on the normal slope of the Sierra Nevada is separated by about thirty to forty miles. Here, then, is perhaps one of the first clues that we have as to the nature of a climatic boundary. Between the valley floor and Glacier Point there is a sharply defined climatic boundary. On a map it may be drawn as a line. In nature it is the steepening of the climatic gradient to the degree that horizontal distances are, in effect, telescoped. This, it seems to me, is precisely the nature of the boundary that circumscribes many of our vegetation zones, such as the redwood forest and the steep gradient of humidity, probably deserts and rain forests and many others. They are all to be related to topographic features that sharply interfere with the normal climatic gradient.

But does this explain the position of the boundaries of the banded vegetation of the west slope of the Sierra Nevada? If it does, I can see no topographic feature or other obstruction to the normal climatic gradient that would account for it. I will not go so far as certain eastern ecologists and argue that the banding of vegetation is an illusion brought about by biotic factors involved in the distribution of the dominant species. Competition is called in to account for the boundary between the main forest species of the so-called zones. My reason for turning this argument down is that I think I can put my finger on the precise cause of the boundary of the Transition and Upper Sonoran zone, but as yet I do not know how it operates. It is the line of persistence of winter snow. I think if this feature were studied across the continent it would be found to be a vegetation boundary of great significance. I think

it is a major feature in the boundary of the Pinyon-juniper and the sagebrush. A technical point might be raised as to whether this in its effect on the plant is edaphic or climatic. That problem will have to wait until we know what its effect is.

As to the boundaries of the higher zones, they are quite puzzling. I have wondered to what extent the historical factor has entered the problem. The main transition belt is below the zone of heavy glaciation. There was not the complete revolution of the edaphic habitat as characterized the higher zones. The upper limit of the transition zone conforms in many places with lower limit of often recurring glaciation. There is evidence that this flora is much older than the higher floras, certainly its terrain was available for population for a much longer time.

I doubt if there is a boundary between the so-called Canadian and Hudsonian, but timberline is another matter. It is a problem around which a great many minds have milled with no satisfactory results. Above timberline on many mountains, but not in the Sierra Nevada, is another boundary that is very definite. It again is related to snow. It is the boundary of perpetual snow in other than the protected places and is the so-called niveal zone.

After the presentation of Dr. Mason's paper, an extended discussion followed, participated in by most of the members present. The meeting adjourned at 4:10 P.M.—E. G. LINSLEY, Secretary.

One Hundred and Eighty-sixth Meeting

The one hundred and eighty-sixth meeting of the Pacific Coast Entomological Society was held at 2:30 P.M., on June 16, 1945, in the entomological laboratories of the California Academy of Sciences, San Francisco. Dr. R. C. Miller in the chair. The following members were present: R. C. Miller, E. G. Linsley, E. A. Steinhaus, J. W. MacSwain, A. E. Michelbacher, E. C. Van Dyke, and P. Moorhead. Visitors were present as follows: Dr. S. E. Flanders, Dr. R. Goldschmidt, Mr. M. W. Allen, Miss J. Fayette, Mr. O. G. Bacon, Mr. C. H. Martin, Mr. L. Brown, and Mrs. B. Prendergast.

The minutes of the previous meeting were read and approved.

The membership committee proposed Dr. C. M. Herman and Mr. C. H. Martin for membership in the Society. They were unanimously elected.

Dr. Miller announced the death of Mr. P. C. Grassman, killed in action on December 4, 1944.

Dr. Van Dyke reported the whereabouts and current activities of various members of the Society in the armed forces.

Mr. MacSwain reported that he had spent two months during the late spring in New Mexico, where he had given special attention to the rearing of meloid beetles. He reported particular success in obtaining oviposition under laboratory conditions when the adults were provided with an adequate daily supply of their native food plants.

Dr. Miller then presented Dr. Stanley Flanders of the Citrus Experiment Station, Riverside, California, who addressed the Society on "Environmental Determination of Sex in Hymenoptera", a summary of which follows:

The effectiveness of the parasitic insect in biological control work is determined largely by the searching capacity of the female population, since it is the female that carries the following generations. Consequently, the fact that the Hymenoptera possess a unique mechanism for determining the sex of the individual increases the capacity of parasitic forms to control their hosts. Any condition which determines the sex ratio of a population does so by determining the sex of the individual except in cases when the ratio is determined by the differential mortality of the sexes. The production of females in lieu of males is favored by any factor which insures the continuance of reproduction. In the field the factors of environmental resistance which insure the continuance of reproduction by preventing over-population of an area tend to cause female predominance. In the insectary production of parasitic Hymenoptera, on the contrary, where searching is unnecessary and environmental resistance is low, precautions must be taken to prevent loss of female production through excessive male production.

In species that reproduce uniparentally such as *Habrolepis rouxi* the sex of the individual is determined very early in its ontogeny, prior to the reduction divisions, apparently as a nutritional effect of the environment on the doubling or lack of doubling of the inherent diploid constitution of chromosome material.

In species that reproduce biparentally such as *Coccophagus ochraceous* the sex of the individual is determined at the time of egg deposition. If unfertilized the egg remains haploid and is therefore a uniparental male; if fertilized the egg become diploid and therefore a biparental female. The densities of populations may determine the sex of individuals by influencing the time of mating, the amount of sperm available for fertilization, the rate of oviposition or the preferential nature of the oviposition site.

The fact that in the social Hymenoptera the formation of castes is limited to the female sex indicates that the determination of castes is associated with one or more of the factors influencing the fertilization of the eggs.

Biologically the position of the Hymenoptera in relation to other animals is most clear when animals are segregated according to the types of sexual individuals composing each species. These individuals are (1) those that are obligatorily biparental, (2) those that are obligatorily uniparental, and (3) those that are facultatively uniparental and biparental.

Group A: Includes species in which all individuals, male and female, are obligatorily biparental: *mammals, birds,* and *house flies.*

Group B: Includes species in which all individuals, male and female, are either obligatorily biparental or obligatorily uniparental: *aphis* and *thrips*.

Group C: Includes species in which all individuals are obligatorily uniparental: *black scale* and *vegetable weevil*. Males, if they occur, are nonfunctional.

Group D: Includes species in which most individuals either are facultatively biparental females or uniparental males: *red spider*, *whitefly*, *honey bee*, and *various parasitic Hymenoptera*.

In group C we have the uniparental red scale parasite *Habrolepis rouxi* in which the sex of the individual can be changed by modifying the food of the parent. By proper manipulation of host and host plant, females can be obtained that produce all male offspring which under other circumstances would have produced all female offspring. Mating in this species never occurs.

A change in the sex of individuals commonly occurs in the species in groups B and D through the effect of changes in population densities.

Aphis and thrips may produce females uniparentally for generations and then switch to the uniparental production of males as well as females. These individuals mate and produce biparental progeny (usually all females). The switch from non-mating females to males and females capable of mating is probably brought about by some chemical factor associated with crowding of the population.

Following a discussion of Dr. Flander's paper, the meeting adjourned.—E. G. LINSLEY, Secretary.

One Hundred and Eighty-seventh Meeting

The one hundred and eighty-seventh meeting of the Pacific Coast Entomological Society was held at 2:00 P.M. on September 22, 1945, in the entomological laboratories of the California Academy of Sciences, San Francisco. The following members were present: C. D. Duncan, E. G. Linsley, E. L. Kessel, W. F. Barr, E. C. Van Dyke, M. A. Stewart, R. C. Miller, J. F. Lamiman, J. W. MacSwain, Ray F. Smith, and M. W. Allen. Visitors were present as follows: Nuri Malih, G. L. Smith, S. Kennedy, R. Schuster, B. Adelson, and B. P. Prendergast.

The minutes of the previous meeting were read and approved.

The chairman called for notes, observations, or exhibits from members.

Prof. Ferris exhibited drawings of mealybugs from his project on mealybugs of North America, as part of his general series entitled "Atlas of the Scale Insects of North America." He stated that there were now somewhere between 200 and 250 species available for study, each of which would be drawn in detail. He emphasized the necessity for good preparations and pointed out that drawings should be regarded as maps, and should include every

hair, pore, or mark on the body. Prof. Ferris discussed the use of certain-labor saving devices which he had found helpful but stated that even when these were utilized, two days were required for each drawing. He stated that up to the present point in his work, a generic classification was not yet evident. He also commented that although mealybugs can be classified by morphological means, biological evidence indicates the necessity of further division in many cases.

Dr. Duncan exhibited a piece of horn which had been badly damaged by *Dermestes*. He also reported the fact that he had been bitten upon occasion by ladybird beetles, in particular *Coccinela californica* and *C. transversoguttata*.

The chairman then presented Dr. E. C. Van Dyke, an Honored Member of the Society and Honorary Curator, Department of Entomology, California Academy of Sciences, who addressed the Society on "The Entomological Collection of the California Academy of Sciences." A summary of Dr. Van Dyke's address follows:

The present entomological collection practically dates from the time of the San Francisco earthquake and fire, April, 1906, for at that time all collections were destroyed, including the large and valuable H. H. Behr collection of Lepidoptera and the smaller general collections of insects, chiefly prominent because of the serial collections of Lower California insects collected on the earlier expeditions to Lower California. The only specimens saved from the catastrophe were about twelve boxes of types, which were removed and stored temporarily at Fort Mason.

As soon after the fire as possible, the Academy rented temporary quarters in the wholesale district of the city, and began the work of building anew. The Galapagos Expedition was at sea at the time but it returned soon after. The entomological material collected by F. X. Williams was thus the nucleus of our new collection. Within a short time, the Academy began to receive many small but valuable collections such as that of: J. G. Grundel, Lepidoptera, in 1908; the W. G. Wright collection, 1910, the basis for his publication, "The Butterflies of the West Coast," as well as the unsold volumes of his work; the F. X. Williams, 1916, E. J. Newcomer, 1917, collections of Lepidoptera and the Entomological Department of the University of California, in 1918, deposited the residue of the R. H. Stretch collection of Lepidoptera. For several years before the fire and until after I entered the University, I acted as curator and Mr. Charles Fuchs, as preparator.

In 1916 Mr. E. P. Van Duzee became curator. The growth of the collection was soon accelerated by the donation of several large collections such as the E. C. Van Dyke collection of Coleoptera, 1924; the E. P. Van Duzee collection of Hemiptera, 1925; the F. E. Blaisdell collection of Coleoptera, 1925; the Albert Koebele collection of Lepidoptera and Coleoptera, 1926; and several smaller collections; The H. M. Holbrook collection of showy

exotic butterflies, 1924; the L. S. Slevin collection, 1927, the C. L. Fox collection, 1928, and J. O. Martin collection, 1928. From that time on valuable additions became more frequent. In Lepidoptera we received the collection of E. A. Dodge, Sphingidae from Preston Clark, the collections of Graham Heid, Wm. Hovanitz, Tom Craig, and Mr. Huguenin, besides many fine specimens from Father Guedet, Dr. Wm. Barnes, and others. In Coleoptera, the larger acquisitions were the Dr. Albert Fenyes collection, those of E. Gorton Linsley, J. Linsley Gressitt, F. C. Hadden, Dr. Killeen, H. M. Armitage and others. In the Hemiptera we have received considerable material from W. M. Giffard and the Wymore collection of Cicadidae. In the Hymenoptera, our main gifts were from C. L. Fox, Dr. Isabel McCracken and Mr. Weld and through the purchase of the M. C. Van Duzee collection. In the Diptera, we also received valuable additions from the last-mentioned collection, also from Professor Doane, E. A. Dodge and others. Others who contributed greatly to the upbuilding of all orders were Dr. E. S. Ross, Mr. Huguenin and so forth.

Our collection as it is today comprises well over a million and a half specimens. The richest parts are the North American and Oriental portions and the largest number of specimens are in the Coleoptera. The Coleoptera collection is in fact one of the finest in the country. The families which are outstanding because of their completeness, particularly as regards North American and Oriental forms, are the following; Carabidae, Dytiscidae, Staphylinidae because of the Fenyes Aleocharinae, a fairly good collection of Coccinellidae, the Elateridae, Buprestidae, Tenebrionidae, Melyridae, Histeridae, Cerambycidae and Rhincophora.

The Hemiptera collection is also one of the good collections in the country and the other orders will in time show to better advantage when we receive a sufficient number of cases to enable the material which we have on hand to be properly assembled and systematically arranged.

To back up our collection and make it more available for study purposes, we also have a first class library which is growing rapidly. The Academy is, therefore, becoming one of the outstanding institutions in the country for entomological research.

Following Dr. Van Dyke's address, there was considerable discussion. Dr. Miller, as Director of the Academy, stated that much thought was being given to the future of the Entomology Department, and expressed appreciation to Dr. Van Dyke for the services which he had rendered in the past, and especially during the critical war years.

The meeting adjourned at 4 P.M.—E. G. LINSLEY, Secretary.

One Hundred and Eighty-eighth Meeting

The one hundred and eighty-eighth meeting of the Pacific Coast Entomological Society was held at 2:30 P.M. on January 12, 1946,

in the entomological laboratories of the California Academy of Sciences, San Francisco. President Keen in the chair. The following members were present: F. P. Keen, E. G. Linsley, G. F. Ferris, J. B. Steinweden, B. Walker, P. C. Ting, P. Moorhead, A. E. Michelbacher, E. O. Essig, C. D. Duncan, F. J. Driver, H. P. Chandler, E. L. Kessel, W. F. Barr, J. W. Tilden, A. R. Mead, W. H. Lange, J. F. Lamiman, E. C. Van Dyke, R. W. L. Potts, K. E. Frick, H. F. Madsen, M. W. Allen, E. A. Steinhaus, J. W. MacSwain, R. F. Smith, and R. C. Miller. Visitors were present as follows: N. F. Hardman, W. W. Middlekauff, E. S. Dethlefsen, H. H. Welsh, W. E. Ferguson, E. Dietrich, D. Stewart, H. J. Jensen, C. Stojanovich, C. D. Grant, J. F. Gustafson, J. M. Coarsey, G. Marino, H. Tilden, M. B. Piazza, S. R. Piazza, P. D. Hurd, Jr., F. M. Frick, K. S. Snyder, Mr. and Mrs. A. Troxel.

The minutes of the previous meeting were read and approved.

The membership committee proposed the following for membership in the Society: N. F. Hardman, Chester Stojanovich, Salvador R. Piazza, William E. Ferguson, Woodrow W. Middlekauff, Hartwell H. Welsh, C. Donald Grant, Joel F. Gustafson. They were unanimously elected.

The nominating committee proposed, and the Society elected, the following officers for 1946: C. D. Duncan, President; E. G. Linsley, Vice-President; E. S. Ross, Secretary; R. C. Miller, Treasurer, and R. W. L. Potts, Member-at-Large, Executive Committee.

The retiring President then turned over the gavel to the new President, Dr. Duncan.

Prof. Ferris discussed labor-saving devices in entomological drawing. He pointed out that the lithoprint process had made illustration profitable from the standpoint of cost, and exhibited specimen pages from *Microentomology* which utilizes the process. He also showed transparent sheets covered with stipple which can be used to save time in the preparation of certain types of illustrations. He concluded his remarks on entomological drawing with emphasis on the necessity for labelling all illustrations in full and avoiding abbreviations.

Dr. Duncan exhibited a flaw in a sheet of paper which had obviously been caused by a polystoechodid which had been crushed during the manufacturing process. He suggested that such flaws may possibly be rather generally caused by insects.

Dr. Duncan then presented Mr. F. P. Keen, retiring President, who addressed the Society on "Entomology in Western Pine Silviculture" (see p. 1.). After a lively and interesting discussion of Mr. Keen's paper, the meeting adjourned.—E. G. LINSLEY, Secretary.

LOOKING FORWARD

BY T. D. A. COCKERELL
Boulder, Colorado

It is generally agreed that the postwar world should be distinguished by progress, by many developments of many kinds intended to make life more worthwhile. It is an appropriate time for those who have projects in mind to set them forth, with the idea that although they may seem of minor importance in relation to the whole country, they may have their value as parts of a plan which must be made up of many parts. I will accordingly discuss two projects which are just now in my mind.

Zoology of the Pacific Coast States

I should like to see begun a work on the zoology of the Pacific Coast region after the manner of *The Fauna of British India* which has long been in course of publication. Such a work would be of the greatest value and I do not see any reasons against it. The volumes would be issued as they could be prepared and as funds were available for publication. Extinct as well as living species, and the fauna of the sea, should be included. It would be many years before the work could approach completion, and it would never be finished since as in the case of *The Fauna of British India,* the earlier volumes would have to appear in revised editions. To those who will say that the funds cannot be found for such a project it may be replied that as a matter of fact California can very well afford to finance the initial volumes, and as the work would be a standard one it would be taken by all the larger libraries, and all institutions where they did zoological work.

Laboratories Around the World

Many years ago, after visiting Siberia and other countries, I thought it might eventually be possible to establish a chain of laboratories or field stations all around the world, provided with the necessary books and apparatus, and open to all properly qualified students. A graduate student in zoology might then spend a few months in each place, getting acquainted with the local naturalists and studying the fauna, or such parts of it as specially interested him. Surely such an experience would be of the greatest value, and would often result in international friendships and cooperation.